N67 17837

17837 (ACCESSION NUMBER)	(THRU)
50 (PAGES)	(CODE)
CR-66264 (NASA CR OR TMX OR AD NUMBER)	21 (CATEGORY)

FACILITY FORM 602

NASA CR-66264

SPACE PROBE RADAR ALTIMETER STUDY

Volume III

RELIABILITY AND QUALITY ASSURANCE PLAN

GPO PRICE $ ______

CFSTI PRICE(S) $ ______

Hard copy (HC) ______

Microfiche (MF) ______

ff 653 July 65

November 1966

Distribution of this report is provided in the interest of information exchange. Responsibility for the contents resides in the organization that prepared it.

Prepared under Contract No. NAS 1-5953

by

WESTINGHOUSE ELECTRIC CORPORATION
Aerospace Division
Baltimore, Maryland

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Langley Research Center
Hampton, Virginia

SPACE PROBE RADAR ALTIMETER STUDY

Volume III

RELIABILITY AND QUALITY ASSURANCE PLAN

November 1966

Prepared under Contract No. NAS 1-5953

by

WESTINGHOUSE ELECTRIC CORPORATION
Aerospace Division
Baltimore, Maryland

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Langley Research Center
Hampton, Virginia

FOREWORD

Westinghouse Electric Corporation, Aerospace Division, Baltimore, Maryland has investigated the system requirements of a radar altimeter applicable to deep space probes. The study has been conducted under contract NAS 1-5953 with the National Aeronautics and Space Administration, Langley Research Center, Hampton, Virginia. The Westinghouse order number was 4AD-53449.

The results of the study are presented in three volumes. Volumes I and II are the technical report and development plan, respectively. This document, Volume III, describes a Reliability and Quality Assurance Plan for the altimeter's design, development and production.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

The Reliability and Quality Assurance Plan described in this document establishes the minimum requirements for an organized, comprehensive reliability plan as part of the Space Probe Radar Altimeter (SPRA) program. It deals with the effort of the Westinghouse Electric Corporation, Aerospace Division, during all phases of the altimeter's design, development and production. The plan complies fully with NASA document NPC-250-1, "Reliability Program Provisions for Space System Contractors."

The described plan integrates the reliability tasks required by the SPRA with the skills of the Aerospace Division's Reliability Engineering Department. The tasks outlined are implemented with proven procedures and techniques which are the results of Westinghouse experience on other successful NASA programs. Such programs have been the Gemini Rendezvous Radar, the Lunar Television Camera, and the Environmental Measurements Experiment for the ATS.

Westinghouse experience indicates that technical compliance with contract provisions alone will not guarantee a reliable product. However, the company believes that the chances of producing a reliable product will be greatly increased if the provisions of this plan are followed, both technically and in spirit.

PROGRAM SUMMARY

Westinghouse will exercise effective reliability control over all in-plant and purchased products by implementing the following program:

(a) Apportioning the reliability requirements to all components of the system.

(b) Requiring suppliers to determine all pertinent operating characteristics and strengths of all materials, components and parts used in the system under the anticipated operational stresses and environments..

(c) Providing assurance that:

(1) adequate safety margins or derating exists in all parts, components, and materials, such that each part and component will meet or exceed its apportioned reliability requirement under anticipated operational loads and enviroments:

(2) the design is an optimum for its use: and

(3) the reliability of the final product meets or exceeds the specified requirements.

(d) Planning and conducting test programs so that the test results can validate predictions and assumptions made in analysis.

(e) Establishing procedures to ensure that the inherent reliability attained in the design will be maintained during fabrication and testing.

(f) Establishing reporting procedures which will allow NASA to conveniently monitor all phases of the program.

Equipment sterilization for deep space probes may degrade the characteristics of some component parts. Westinghouse has previously studied this problem and will establish controls on the SPRA program such as design from an approved list of parts plus sample testing to ensure adherence to specifications.

RELIABILITY PROGRAM MANAGEMENT

Program Directors

The direct responsibilities for the SPRA reliability and quality lie with the Program Manager. Because of the importance of the task, however, these responsibilities are delegated to two program specialists, the Director of Reliability Engineering and the Director of Quality Control.

The Director of Reliability Engineering is primarily concerned with the design phase of the program. The Director of Quality Control oversees the subsequent manufacture of the SPRA system. As a matter of policy, the Westinghouse Aerospace Division closely coordinates these two efforts to ensure continuity from development through production of the system.

Responsibilities

The overall responsibility of the Director of Reliability Engineering is to implement the tasks described in this program plan. Aiding him are the specialists in the Aerospace Division Systems Reliability Engineering and Component Parts Engineering groups.

The Director's specific resonsibilities are to:

(a) prepare and implement the Reliability Program Plan.

(b) organize and control a reliability operation adequate to execute the program plan.

(c) formulate and apply the procedures required to execute the program.

(d) coordinate the Reliability and Quality Control operations with the Director of Quality Control.

(e) continuously monitor the reliability aspects of the program and keep project personnel, project management and the customer abreast of the status of the reliability effort.

Reliability Control

Another requirement for good system design is a good working relationship between reliability engineering personnel and the detail design engineers. To assure that optimum techniques are used, the design engineers will be provided with:

(a) the current reliability apportionments and estimates for those parts and assemblies for which the designer is responsible.

(b) all other design requirements such as performance, space, weight, interface and interaction requirements.

(c) all pertinent analyses such as design configuration, failure effect, circuit and heat transfer.

(d) preferred parts lists with parts characteristics such as tolerances, ratings and failure rates.

Reliability Indoctrination and Training

During this program there will be two levels of indoctrination and training.

Engineering and management.-Reliability indoctrination and training at this level is a continuous program at the Aerospace Division. To provide management and engineering personnel with the unique reliability aspects of this program, informal reliability training sessions will be conducted during the program.

Manufacturing, test and handling personnel.-The personnel involved in building, testing and handling this equipment will be trained through a series of motivation and training classes conducted by the Quality Assurance Group. This program will be described later under the Quality Program Plan.

Subcontractor and Supplier Control

Subcontractors and vendors will be surveyed to assure that the required reliability is achieved during design, and that the quality of their products is maintained throughout the program.

The following steps will assure the meeting of these goals:

(a) Each vendor will be surveyed as to capability of meeting the reliability and quality requirements.

(b) The vendor will be inspected periodically to determine compliance with the reliability and quality requirements.

(c) Where required, there will be source inspection by Westinghouse inspectors.

(d) Records will be kept of vendor performance in the areas of quality and reliability and periodic reviews will be held to determine compliance.

(e) Purchased parts will be tested periodically to assure their integrity after decontamination and sterilization. This test program will be monitored by the reliability engineer to ensure close follow-up and connection in problem areas.

The prime responsibility for control of subcontractors and suppliers rests with the quality assurance group. However, the reliability aspects of control will be coordinated with reliability engineering.

Program Reviews

The Director of Reliability Engineering and the NASA Langley Research Center (NASA/LRC) program representative will jointly conduct formal reviews of the reliability program to assess the programs progress and effectiveness. These reviews will be documented and reports submitted to the NASA/LRC technical officer.

SYSTEM RELIABILITY ENGINEERING

Reliability Engineering is an integral part of all phases of the design and development process. This section of the program plan describes the basic elements of the SPRA reliability engineering effort.

Design Specification

The Director of Reliability Engineering will review and concur on all Westinghouse-generated drawings of functional assemblies and all specifications of performance and interfaces. This will assure that environmental requirements, pertinent test criteria, safety margins, and derating factors are sufficient to meet the apportioned reliability goals. As these specifications and drawings are updated all changes and revisions will be reviewed by the Director to determine their effect on reliability prior to approval for release.

Analysis of Failures and Their Critical Effects

An analysis of all conceivable failures and their effect on the SPRA mission capability will be conducted during the design phase. The analyses will uncover critical reliability areas and direct appropriate attention to them.

In the early design stages the analysis will consider the consequences of failure at the higher assembly level. In the later design stages the analysis will be at the circuit level and related to the piece part failure analysis during the circuit analysis. The failure effect analyses will involve the following considerations:

(a) Functional block diagrams will define the operation of the subsystem and functional groups of circuits or components. The design output requirements for each functional block will be indicated on the diagram.

(b) It shall be assumed that each block fails in turn. A systematic procedure will be followed whereby, for each block, each output signal is assumed to fail in its most critical position or under its most adverse condition. All environmental conditions and operating stresses will be considered. Any condition whereby the output does not meet the design output requirements shall be denoted a failure. The procedure will assure consideration of all conceivable failure modes at the circuit level and higher.

(c) Symptoms and consequences of each failure on the next higher level of assembly and on the mission capability will be included in the failure modes and failure effects report.

(d) Also included will be a numerical probability of failure, a safety margin, and the derating at high temperature.

(e) Failures will be classified as follows: I. Equipment inoperative or badly degraded; II. Equipment slightly degraded; III. Equipment not affected, nuisance failure.

(f) If tests are necessary to verify the consequences of assumed failures, test plans will be submitted to NASA/LRC for approval prior to starting.

Reliability Apportionment

To achieve the overall system reliability goals, the reliability requirement will be apportioned among the various system components. Such apportionment will be on the basis of their relative complexity and relative importance to the success of the mission as indicated by the failure effects analysis. Refinement of the apportionment during the progress of the design will reflect any deviations from the initial assignments. The monthly Reliability Progress Reports will document any such deviations.

Reliability Circuit Analysis

A computer-augmented circuit analysis during the design phase will assure early application of reliability methods and techniques. The computer program to be used is one developed by IBM entitled Electronic Circuit Analysis Program (ECAP). This program will perform the following types of analyses:

(a) DC Analysis - to check for proper biasing of semiconductors

(b) Standard deviation - to check for variation of dc voltages with part parameter changes

(c) Sensitivity - to check which part parameter change causes the major effect on the voltage in question.

(d) Part power dissipation and voltage drop - to check reliability by stress ratios.

(e) AC Frequency Response - to check open loop gain for feedback cicruit stability studies.

(f) Transient - to determine the effects of transients and to analyze digital circuits such as flip-flops.

In addition to these specific checks, part parameters can be varied to represent the effects of temperature, humidity, aging, etc. Thus the resulting effects on the circuit can be found.

The circuit analysis program will be conducted by the reliability engineer in conjunction with the electrical and mechanical designers and the parts reliability control engineer.

During the circuit analysis program the following considerations will be given to each part in each circuit;

(a) Part performance required
(b) Loading
(c) Environmental conditions
(d) Derating under environment
(e) Expected failure rates with (c) and (d).
(f) Mode of failure in given environment
(g) Symptoms and consequences of the failure mode on the circuit

Reliability Predictions and Estimates

All phases of the design effort will be monitored and up-to-date estimates of the system will be maintained. These estimates serve to assess the progress in achieving the specified reliability and underscore existing problem areas.

Reliability estimates will be prepared on accordance with MIL-STD-756A, "Military Standard Reliability Prediction." The failure rates used will be those of Mil-Hdbk-217A, "Military Standard Reliability Prediction." However, more favorable failure rates based on selected proven parts may be used subject to approval by NASA/LRC. Consideration of approval will be based on supporting data such as environmental test results, availability, etc.

Periodic status reports will be submitted to NASA/LRC comparing the reliability estimates with the apportioned reliability requirements and pointing out those areas of anticipated or potential trouble.

Review of Parts Reliability Data

All vendors supplying parts for flight hardware are required to furnish serialized acceptance and qualification data with the parts. As part of the reliability control program the reliability engineer will review this data prior to release of the parts to stores.

The data will be reviewed and compared to the part requirements to determine if there exists any abnormality which may indicate a marginal condition. If an abnormality is found the vendor will be contacted and corrective action taken prior to release of the parts to stores.

Failure Reporting, Analysis, and Corrective Action

All discrepancies or failures occurring in the SPRA program will be processed by the Westinghouse Discrepancy Reporting and Corrective Action Program.

The first element of this program affects the individual piece parts as it is delivered to the Aerospace Division. Before the part is accepted for use it is measured and tested for conformance to applicable Westinghouse purchased part requirements, and the vendors test data is reviewed.

If a part does not conform to all requirements of the drawing, the lot of parts is held, and a Material Rejection Notice (MRN) is written. The MRN goes to the Material Review Panel consisting of a Quality Control Engineer, a Parts Reliability Control Engineer, and a Project Design Engineer. This panel analyzes the MRN, decides upon the proper corrective action, and determines the disposition of the parts.

The next element of this program occurs at the assembly stage. If at this stage a part is damaged or found to be defective, a Defective Apparatus (DA) tag is filled out and attached to the equipment. The Quality Assurance group takes corrective action on each defect and maintains a file which is monitored periodically to determine if there is a significant trend of defects.

Once a subassembly or module has progressed to the circuit check level all discrepancies thereafter are processed using the discrepancy reporting system and report form BA5144 (see Appendix A).

The discrepancy reporting system is a detailed procedure to collect data on failure, maintenance, and consumption data, and to provide accurate and timely transmittal of this data to all departments concerned.

Breadboard phase failures.-Failures or discrepancies occurring during the engineering breadboard phase will be reported directly to the Reliability Engineer on form BA5144. It will be the Reliability Engineer's responsibility to initiate action to have the failure analyzed and to established a feedback loop such that the required corrective action is taken. A file of all breadboard failures will be maintained for Westinghouse internal use to assure adequate reliability coverage of this phase of the program. Breadboard failure reports will not normally be submitted to NASA/LRC but may be reviewed upon request.

Engineering model and qualification system failures.-Every failure and/or discrepancy occurring in Engineering Model or Qualification systems will be reported to NASA/LRC. The discrepancy report number will be recorded with the failure data in the system log book along with the failure data. The discrepancy report and failed part will be routed to the Reliability Engineer.

The Reliability Engineer is responsible for processing the discrepancy report as follows:

(a) Tabulate the failure and pertinent data and inform responsible design engineer.

(b) Prepare and forward to NASA/LRC a report of the failure.

(c) Forward the discrepancy report form and parts to the product reliability assurance laboratory for analysis, if required.

(d) When required return the failed parts to the supplier for analysis and corrective action.

(e) Tabulate the results of the failure analysis and bring them to the attention of the responsible designers and program management.

(f) Tabulate the corrective action measures and follow up to assure its effectiveness.

(g) Forward a complete failure report to NASA/LRC. This report will include the failure report number, date of failure, system serial number, nature of failure, test procedure reference, cause, effect on system, reparability, and the corrective action.

Production phase failures.-The failure reporting, analysis and corrective action procedures for the production phase (beginning with the production prototypes) of the program will be in accordance with the Quality Assurance Program Plan described later.

Environmental Effects on Reliability

A study will be made of the effects on reliability due to the environments encountered during sterilization, storage, handling and maintenance of the completed system. The results of this study will be included as an appendix to the final report on analyses of failures and their critical effects.

Design Review Procedures

The following discussion defines the requirements for establishing, conducting, and documenting reviews of the SPRA designs.

Design reviews will be held on all designs and there will be special design reviews as required to examine major changes to the design.

Objective.-The objective of the design review is to promote optimum consideration, implementation and documentation of all design factors at key points in the design cycle. It in no way relieves the design engineer of responsibility for the design.

Design review levels.-Design reviews will be conducted at the following equipment levels:
(a) Module
(b) Subassembly
(c) Wiring (subassembly interconnections)
(d) System

Schedule.-Design reviews will be scheduled as required in the Reliability Program Plan schedule. Design factors to be considered at each review are:
(a) Functional concept
(b) Electrical design
(c) Mechanical design and packaging
(d) Reliability
(e) Produc ibility
(f) Environmental stress
(g) Weight and mechanical stress
(h) Compatibility with other systems and hardware
(i) Test provisions
(j) Safety and operability
(k) Human factors

Inventory.-The design review inventory is a written analysis of a new or changed design, current at the time of the design review far which it is prepared. Design inventories are maintained continously throughout the design program and are assembled for presentation at each design review. Contents of the inventory are:

(a) Design Requirements
  (1) Electrical performance
  (2) Mechanical
  (3) Reliability
  (4) Environmental
  (5) Specifications
(b) Circuit Design Concepts
  (1) Block diagram
  (2) Schematic diagram
  (3) Description of circuit operation
  (4) Parts list
  (5) Alternate designs considered
(c) Mechanical Design Concept
  (1) Mechanical layout
  (2) Mechanical stress considerations
  (3) Weight
  (4) Cooling
(d) Reliability
  (1) Requirements
  (2) Estimate
  (3) Stress analysis
  (4) Parts application data
  (5) Problem areas
  (6) Special and/or critical parts data
  (7) Failure history
(e) Circuit Analysis
  (1) Design calculations
  (2) Tolerance studies
  (3) Failure mode analysis
  (4) Failure effect analysis
  (5) Computer circuit analysis
(f) Test Provisions and Requirements
  (1) Design test data on breadboard models
  (2) Design acceptance test requirements
  (3) Qualification test requirements
  (4) Production test procedures
  (5) Test equipment
  (6) Sterilization test requirements

Design Review Panel

Members.-Members of the design review panel are:
(a) Chairman (Project Reliability Director)
(b) Design Engineers responsible in the areas to be reviewed, i.e., electrical, mechanical, test etc.
(c) Review panel secretary
(d) Consultants

Duties of the chairman.-The panel chairman's duties are to:

(a) Establish design reviews and schedule

(b) Distribute written notice and agenda of meetings, plus design material such as schematics, drawings, etc.

(c) Assist in the selection of specialists with appropriate experience to act as design consultants.

(d) Conduct the design review meetings

(e) Assure recording and distribution of meeting minutes

(f) Take necessary action to implement and follow up the review panel's recommendations

(f) Assure documentation of all action items and maintenance of a permanent design review file.

Duties of responsible design engineers.-The design engineers are responsible for assembling the design review inventory. They will provide copies of this inventory material to the chairman for distribution to the panel members prior to the meeting. This information must be made available in advance of the meeting to allow timely and adequate review of the design prior to the meeting by the design panel members.

Duties of the secretary.-The secretary of the design review panel will record the minutes of the design review meeting and maintain a complete inventory for the design review file. The secretary will generally assist the chairman in implementing the administrative aspects of the design reviews.

Consultants.-Design consultants will be selected from personnel competent to evaluate the particular field represented. The consultants will be selected, both from within and outside engineering, from groups which are not connected with the SPRA project.

Each consultant will be responsible for evaluating the design in the field of his specialty and for studying the design review inventory material.

Each consultant will be required to state that the factors of his specialty have been considered and that the design fulfills all requirements; or that the design is inadequate. In the latter case he will recommend changes to correct the problem.

Design Review Administration

Agenda.-The design review agenda is a brief outline of the design review meeting order of business. It assigns responsibility to specific review panel members and/or responsible engineers for preparing major portions of the design review material. The agenda will accompany a formal notice of the location, time and schedule date of the design review. Figure 1 illustrates the form of such an agenda.

Space Probe Radar Altimeter

Design Review Agenda

Subject of Review ____________________ Date __________

Location ____________________ Time __________

Participants:

Chairman:

Secretary:

Design Engineer:

Consultants:

1.0	Introduction	Chairman
2.0	Review of design inventory for completeness	Chairman
3.0	Presentation of the design	Design Engineer
4.0	Review and discussion of the design per check list	Review Panel
5.0	Preparation of recommendation forms for submittal to the chairman	Review Panel

FIGURE 1.- DESIGN REVIEW AGENDA

Checklist.-The design review checklist is a detailed list of the design factors to be considered in the review. Each item will be examined and its disposition recorded on the list. By indicating whether the design is adequate or inadequate, a summary of the design review is maintained. When the design is found to be inadequate or marginal, recommendations will be made by the review panel for corrective action. Figure 2 illustrates such a checklist.

Recommendation.-Written recommendations by the review panel to investigate or change the design will be made by the panel chairman at the end of the meeting on the recommendation form provided. They will be recorded in the design review minutes as action items. The recommendation form appears in Figure 3.

Action items.-The project Reliability Director will be responsible for follow-up of all action items. As the action items are closed, a full report of the results of the investigation will be prepared and sent to all members of the review panel for their approval. When necessary, a special design review will evaluate the proposed changes.

File.-A complete design review file will be maintained on each item reviewed. This file will include a complete design inventory, the design review minutes, and the complete design review history of the item. The file will include copies of all recommendations, the results of investigations, changes, and test data.

SPACE PROBE RADAR ALTIMETER
DESIGN REVIEW CHECKLIST

System Major Assembly Module Review Level

	Review Item	Submitted to Review Panel	Design Status: Adequate	Design Status: Marginal	Design Status: Inadequate	Remarks and Recommendations
A	Design Requirements:					
1	Electrical					
2	Mechanical					
3	Environmental					
4	Applicable specification					
B	Circuit Design:					
1	Block diagram					
2	Schematic diagram					
3	Circuit description					
4	Parts list					
5	Aternate design					
C	Mechanical Design:					
1	Mechanical layout					
2	Stress considerations					
3	Weight					
4	Cooling					
D	Reliability:					
1	Requirements					
2	Estimates					
3	Stress analysis					
4	Parts application data					
5	Critical parts					
6	Failure history					

E	Circuit Analysis:					
1	Design calculations					
2	Tolerance studies					
3	Failure mode					
4	Failure effect					
F	Test Requirements:					
1	Breadboard test data					
2	Acceptance test requirements					
3	Qualification test requirements					
4	Production test procedures					
5	Test equipment					
6	Sterilization test					
G	Maintainability Factors:					
H	Manufacturing Factors:					
1	Producibility					
I	Safety:					

FIGURE 2.- DESIGN REVIEW CHECKLIST

Space Probe Radar Altimeter

Design Review Recommendations

To: Design Review Panel Chairman

From:

Area of Responsibility ______________________________

I recommend that the following items be investigated for the reasons as indicated:

Meeting Date:

Subject of Review:

Level of Review:

FIGURE 3.- DESIGN REVIEW RECOMMENDATION FORM

PARTS RELIABILITY ENGINEERING

Scope

Within the Aerospace Division the responsibility for implementing an efficient parts control program rests with the Parts Reliability Section. That group maintains an efficient parts control program by:

(a) Starting control at the individual design engineer level.

(b) Vesting responsibility for the parts control portion of a given system with a single parts control engineer.

(c) Providing a convenient method for obtaining proper part selection and application.

(d) Using a built-in process as the system design progresses so that parts are selected, applied, and derated to a predetermined maximum allowable part failure rate consistent with the system reliability requirement.

(e) Minimizing the number of parts and/or part types used in the system.

(f) Developing a part test program that is consistent with the system reliability requirements.

(g) Providing an automated method for accumulating part failure rates and indicating where, what, and how many parts are required both prior to and after release of design drawings.

(h) Initiating parts drawings, as required, that are consistent with the system reliability requirements.

Parts Control Methods

Part control on the SPRA program at the Aerospace Division will be accomplished via the following techniques.

Selection.-There will be controlled selection of all system parts:

(a) A preferred parts list will be prepared in the initial design phase by the Parts Reliability engineer in conjunction with Parts Reliability specialists and the project design section. Once this preferred parts list is established, additions will not be permissible unless it is established that a part not listed provides the required function. Approved deviations will not automatically be added to the approved list, each part being considered in view of the overall requirements.

(b) A parts control engineer (PCE) will be assigned to the Reliability Section of the project to control part selection and applications.

Application.-As it is selected, the application of each part will be controlled. The following questions will be answered for each part application prior to approval:

(a) Is the part designed for the intended function?

(b) Will it meet the sterilization requirements?

(c) Has the part been properly derated to make the application consistent with the design goals?

(d) Considering the system environmental requirements, does the part, as applied, have an anticipated failure rate consistent with the system reliability goal, schedule, and available funding?

Drawings.-Part specification control drawings will be prepared for procuring the desired part when there is no appropriately specified part available. These drawings will contain as a minimum the following requirements:

(a) Electrical performance
(b) Mechanical requirements
  (1) dimensions and weight
  (2) construction
  (3) lead material and finish
(c) Marking
(d) Quality assurance provisions
  (1) quality control requirements
  (2) sterilization requirements
  (3) qualification tests
    - methods
    - data required
  (4) acceptance tests and serialized data required
(e) Qualified vendors selected and listed as suppliers
(f) Reliability requirements
  (1) lot tolerance percent defective (LTPD) or failure rate
  (2) handling by the vendor and Westinghouse
(g) Proper packaging for sterilization, storage, and handling.

Testing.-Westinghouse's incoming receiving department will measure physical and performance characteristics, comparing them with the specified requirements and serialized data.

Storage and handling.-Parts will be properly stored and handled in accordance with the quality assurance plan.

Failure reporting.-A procedure will be establshed for reporting supplier and in-house part failures. The discrepancy reporting procedure will provide timely feedback of information, enabling prompt corrective action.

Parts Control Procedure

Parts lists and the PCE.-Parts selection and control is accomplished using a preferred parts list, a standard format for listing part information, and a parts control engineer (PCE) assigned to the project to guide the design engineers in all aspects of part selection and application.

Parts ordered by the design engineers must be approved by the PCE or the project reliability engineer. Approval consists of the signature of either engineer directly on the purchase order. Thus if any ordered parts are not listed in the preferred parts list, the purchase order is held until the item is reviewed and approved.

During the initial design phase of the program the preferred parts list is prepared by the PCE in conjunction with the project design engineers and the parts reliability specialists (Figure 4). This computer printout will provide such information as part type, drawing number, generic type, relevant characteristics and tolerances, weight, typical cost, and recommended derating.

Handwritten parts list.-Preparation of the parts list begins with the design engineer initiating a handwritten parts list. On Westinghouse form BA 5694A he enters pertinent application and usage data for all parts. This standard company form is shown in Figure 5.

The top portion of BA 5694A identifies the system, the subsystem and the originator of the form. The lower portion lists the parts data. Circuit symbol numbers, part drawing numbers, and circuit stress data are all supplied by the design enginerr.

The PCE then receives the list. He supplies the weight, estimated surface temperature, percent derating, and failure rate data. This application information, updated with all part changes, is always available for design reviews and other activities where accurate, up-to-date information of parts application is required. Other data, such as drawing find-numbers, source codes, assembly drawing numbers, and shop major task numbers, are useful on a company-wide basis.

The original copies of the handwritten parts lists remain with the PCE, while the electrical design engineer, mechanical design engineers, and reliability engineer receive copies. As the parts list is revised, copies are sent to all concerned parties. Any person involved in the design can request a part change, but the change is always reviewed for approval by the electrical designer, mechanical designer, and the PCE prior to changing the parts list.

Keypunch and computer printout.-After parts from several circuits have been tabulated on parts list forms, the keypunch operation begins (Figure 6). The preferred parts list printouts are grouped by subassembly, printed circuit board assembly, and modules. This partial information is immediately available to various activities throughout the division.

Updating.-Since all Change Requests and Revision Notices are routed through the PCE, he is able to keep the parts list current and maintain control over parts selection and application.

As the design drawings are completed the next higher assembly drawing number and find numbers are added to the parts list. As the design progresses and parts lists are released for mechanical design, work requests are submitted by the PCE to the Components Engineering section. The PCE requests the preparation of drawings of items that are not military specification

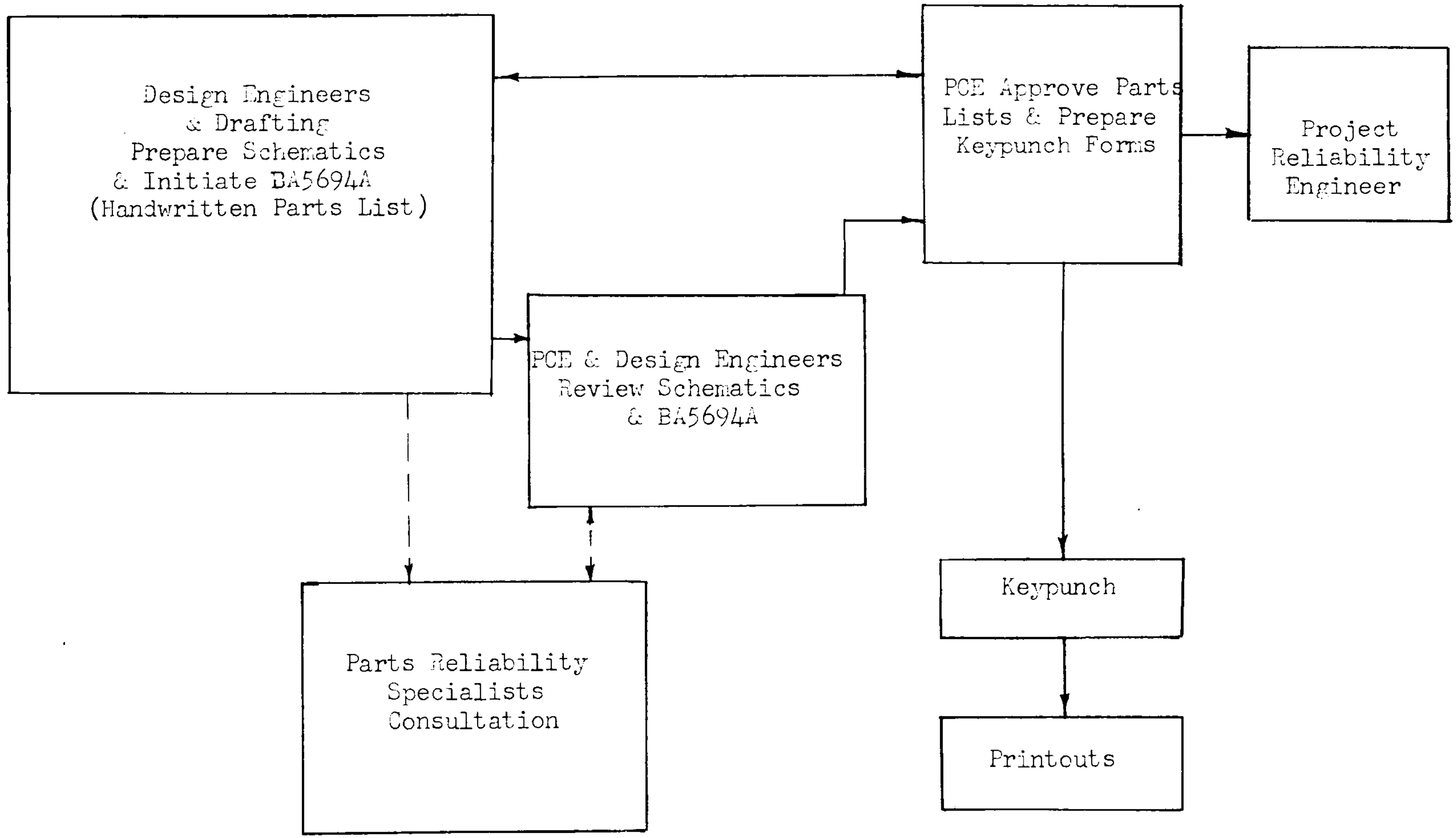
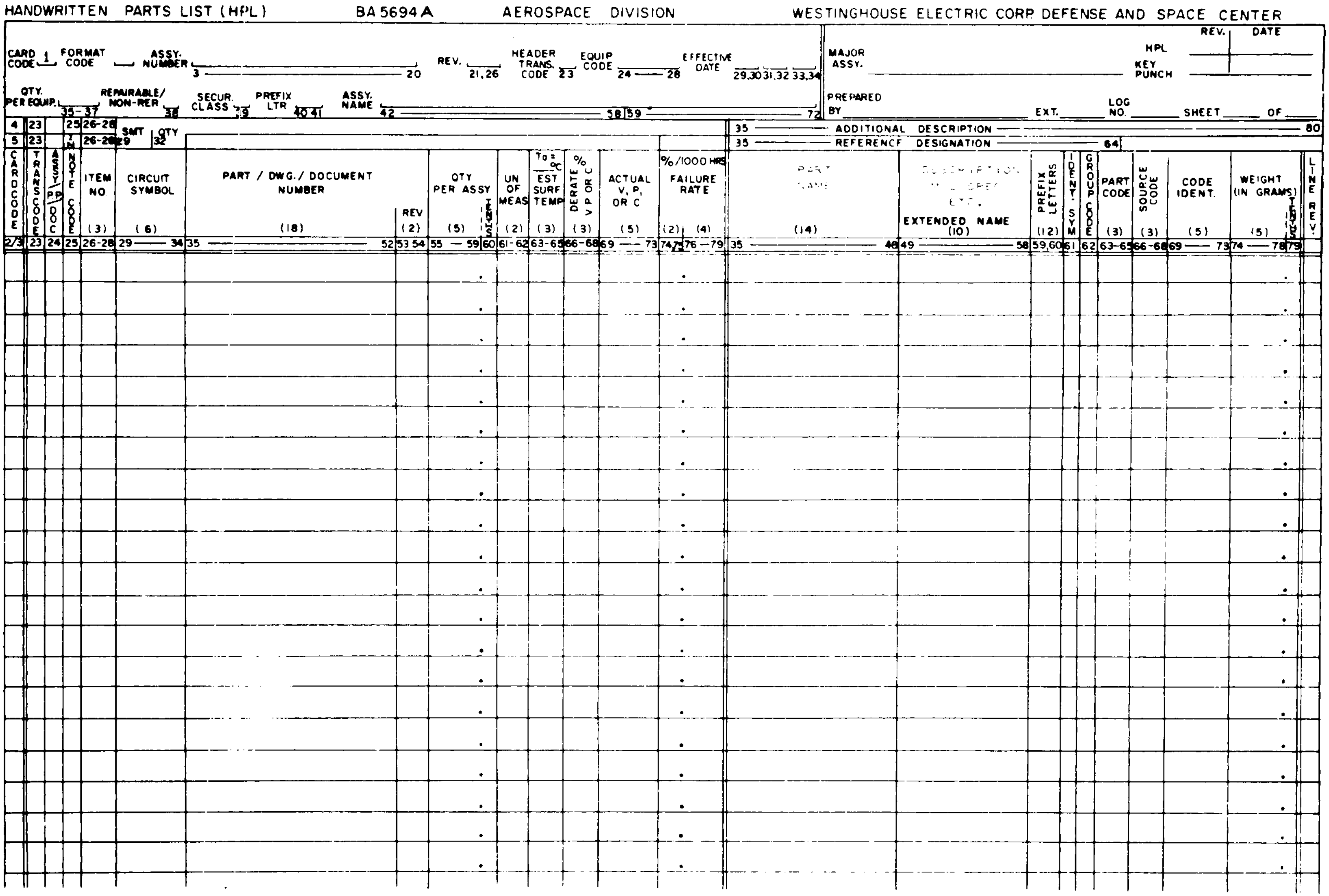


FIGURE 4.- SEQUENCE OF PARTS LIST PREPARATION



HANDWRITTEN PARTS LIST (HPL) BA 5694 A AEROSPACE DIVISION WESTINGHOUSE ELECTRIC CORP DEFENSE AND SPACE CENTER

CARD CODE 1 FORMAT CODE ASSY. NUMBER 3 — 20 REV. 21,26 HEADER TRANS. CODE 23 EQUIP CODE 24 — 28 EFFECTIVE DATE 29,30 31,32 33,34

QTY. PER EQUIP. 35 - 37 REPAIRABLE/ NON-REP. 38 SECUR. CLASS 39 PREFIX LTR 40 41 ASSY. NAME 42 — 58 59 — 72

MAJOR ASSY. HPL KEY PUNCH REV. DATE

PREPARED BY EXT. LOG NO. SHEET OF

4 23 25 26-28 SMT 29 QTY 32

5 23 26-28 29

35 — ADDITIONAL DESCRIPTION — 80

35 — REFERENCE DESIGNATION — 64

CARD CODE	TRANS CODE	ASSY/PP DOC	NOTE CODE	ITEM NO (3)	CIRCUIT SYMBOL (6)	PART / DWG./ DOCUMENT NUMBER (18)	REV (2)	QTY PER ASSY (5)	UNITS	UN OF MEAS (2)	To = °C EST SURF TEMP (3)	% DERATE V P OR C (3)	ACTUAL V, P, OR C (5)	%/1000 HRS FAILURE RATE (2) (4)	PART NAME (14)	DESCRIPTION MIL SPEC ETC. EXTENDED NAME (10)	PREFIX LETTERS (12)	IDENT. SYM	GROUP CODE	PART CODE (3)	SOURCE CODE (3)	CODE IDENT. (5)	WEIGHT (IN GRAMS) (5)	UNITS	LINE REV.
2/3	23	24	25	26-28	29 — 34	35 — 52	53 54	55 — 59	60	61-62	63-65	66-68	69 — 73	74 75 76 — 79	35 — 48	49 — 58	59,60	61	62	63-65	66-68	69 — 73	74 — 78	79	

Figure 5.- Handwritten Parts List Form

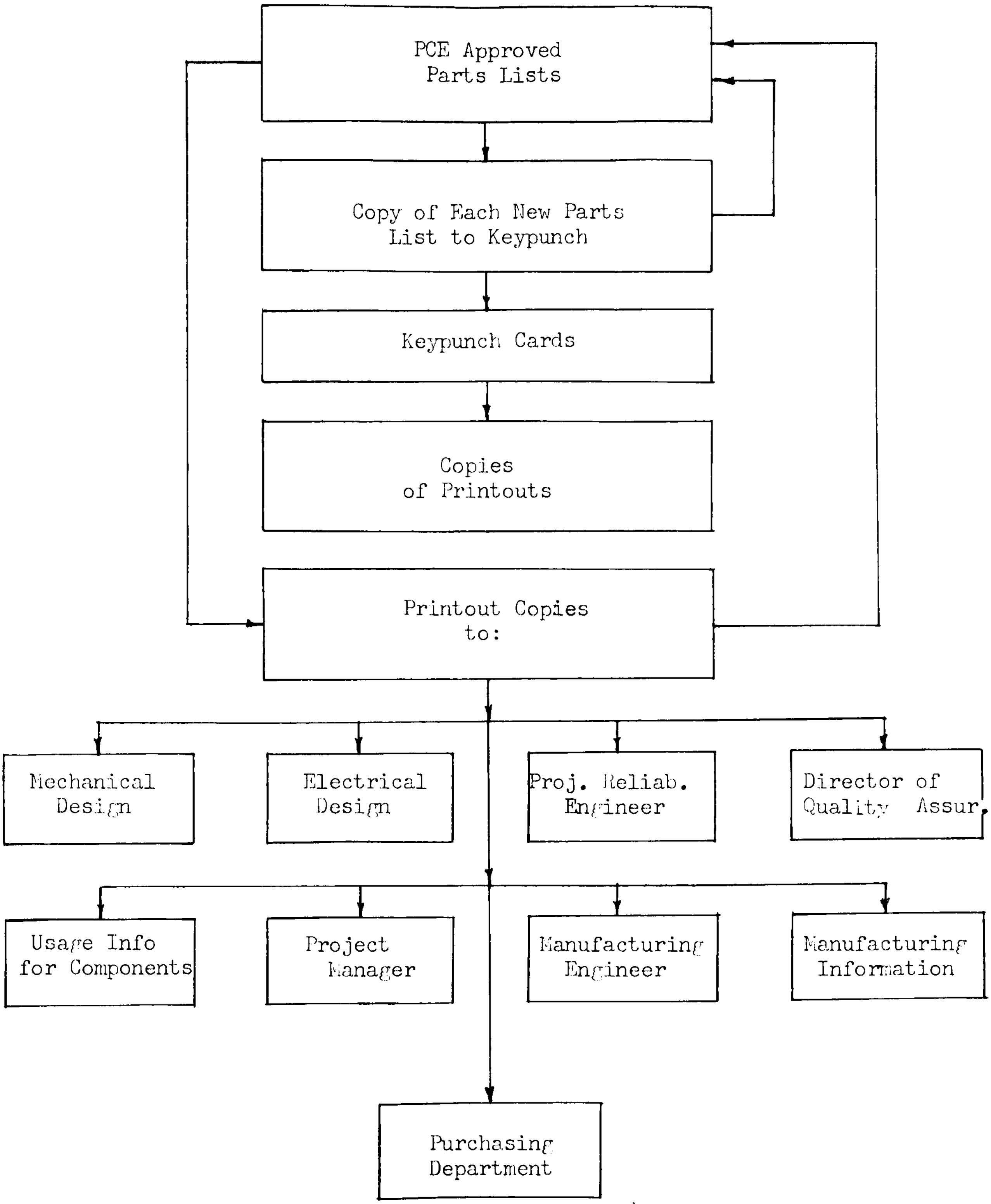


FIGURE 6.- FLOW OF PARTS LIST PRINTOUTS

parts or which for some reason require the preparation of a Westinghouse Specification Control Drawing. The PCE monitors the release of these drawings to ensure that their requirements are adequate and that they are available on time.

When the design is considered firm, the PCE initiates an Advance Order Authorization (AOA), or he reviews and approves by signature all AOA's initiated by design engineering. Records are maintained of part purchase orders and their status from the time of release until the parts are delivered to project stores.

DOCUMENTATION

The reliability effort on the SPRA program will be documented in detail. Where this documentation is required for internal use only, the data will be available at all times during the program to the NASA/LRC technical officer or his representatives. The Director of Reliability Engineering will maintain all reliability documentation, including specific documentation as specified in the contract.

The following reports will be submitted to the NASA/LRC project office:

- Reliability Program Plan--30 days after go-ahead
- Reliability Apportionment--45 days after go-ahead
- Reliability Estimate--120 days after go-ahead
- Failure Effects Analysis--30 days after design freeze
- Approved Parts List--90 days after go-ahead
- Failure Reports--1 week after failure, weekly thereafter
- Design Review Report--30 days after reviews are completed
- Reliability Status Reports--monthly throughout program

QUALITY ASSURANCE PROGRAM PLAN

General

This program plan describes the Product Reliability Department functions and controls that ensure compliance with NASA Quality Publication, NPC-200-2, "Quality Assurance Provisions." Any additional specific contract requirements must be written as supplemental attachments to this plan.

Quality Program Management

The Product Reliability Department has the necessary authority and organization to control the production operations and all related efforts affecting product quality at Aerospace Division. The manager of Product Reliability is directly responsible to the General Manager of Aerospace Division for the quality of all products. For each Aerospace program, the Manager of Product Reliability appoints a Product Reliability Director who is responsible to the Program Manager for the performance of the program quality assurance functions.

Quality Reports (Customer)

Documentation of inspection and tests are maintained and quality reports based on these data are submitted to the customer, as required by contract.

Design Control

Design review.-Product Reliability personnel participate in design reviews to ensure inclusion and adequacy of reliability and quality requirements.

Revision notice control.-A revision notice (RN) procedure provides control and initiates required changes to engineering drawings and related documents that control equipment configuration. The effectivity point of changes that affect materials, fabrication, or performance are clearly defined by the revision notices.

Configuration management.-Configuration management is the responsibility of the Program Manager, who establishes a Configration Control Board (CCB) with himself as chairman. The CCB, as a minimum, consists of representatives of Project Engineering, Manufacturing, and Product Reliability. The CCB processes and approves all RN's according to the RN procedure, the chairman (Program Manager) being responsible for all decisions.

Test equipment configuration and certification.-Test equipment configuration is documented and controlled through the RN procedure. Westinghouse inspects and certifies test equipment prior to use, and records of certification are maintained by the responsible Product Reliability Director.

Control of Procured Material

Vendor survey.-Suppliers are selected based on the type and use of supplies to be purchased, evidence of quality, and any previously demonstrated capability. When evaluation of these considerations dictate, the vendor is surveyed. Surveys are documented and include data pertinent to the vendor's inspection, test and process capabilities, quality control system, controls, procedures, and personnel.

Procurement document review.-Westinghouse reviews documents controlling the procurement of parts and equipment to assure compliance with contractual quality requirements of the end item.

Specification of quality requirements.-Purchase orders will contain a complete description of the supplies ordered. They will include, by statement or reference, all drawing, specification, or contractual requirements, and any requirements for Government or Westinghouse inspections, qualifications, or approvals.

Westinghouse source inspection.-Inspection or surveillance is conducted at a supplier's plant before shipment to Westinghouse when the type of supplies, controls, economy, or quality deem it necessary. All supplies are subject to final acceptance at Westinghouse and/or Government inspection.

Receiving inspection.-Receiving inspection has the responsibility for determining that procured material complies with all applicable drawings, specifications, and procedures.

Vendor rating.-All rejected purchased material is reported. Summary reports of nonconformances help to monitor and evaluate supplier performance and to obtain corrective action. Also they are guides for the selection of suppliers for follow-on and new purchases.

Government Furnished Material

Government furnished property is inspected for shipment damage, completeness, and proper type, and is functionally tested when required by contract. The items are identified, stored, and/or protected from improper use or disposition. Defective Government furnished material is reported to the cognizant Government Representative Control. Procedures are defined by the Westinghouse Baltimore Divisions Manual for the control of Government Property.

Control of Fabrication

Specification conformance inspection.-When required by contract, first units of new production contracts are subjected to a specification conformance inspection. This inspection compares the equipment to the contract requirements, the applicable MIL Specification, equipment test specifications, and applicable drawings. The results of this inspection are documented with any actions required to correctthe nonconformances.

Inspection and test procedures.-The inspection is according to the Product Reliability Department Procedures and Project Directives; also the Test Specifications document procedures necessary to provide uniform control of inspection and test operations.

Inspection criteria.-The criteria for approval or rejection is provided for all inspection operations by means of Products Reliability Procedures and Project Directives, drawings, process specifications and workmanship standards.

Workmanship standards.-The quality of workmanship required from various techniques and processes are documented by workmanship standards. These are used by inspectors to assure compliance and continuing high quality workmanship.

Inspection.-Mechanical inspection is performed at significant points throughout all areas of fabrication, assembly and test. It assures conformance to design, process, quality workmanship and configuration requirements.

Production test (including tooling).-The necessary tooling to perform production testing is designed and made available as an element of the quality program. Testing in accordance with documented procedures and specifications demonstrates the end-use functional requirements of the equipment.

Completed item inspection and testing.-Final inspection and test operations for each unit assures the overall quality of the equipment and its ability to meet end-use requirements.

Inspection records.-Records of inspections are documented by entries made on control tags that accompany the material. Nonconformances are recorded and inspection/test status and acceptance is indicated on the tags.

Test Records.-Test results are recorded on test data sheets or in test log books. These data include appropriate reference to the applicable specifications, procedures, and revision status together with readings/results of the tests performed.

Rejection records-control tags.-Records of nonconformances are made by entering such data on control tags. The control tags of serialized units are retained as permanent quality records for six years, or as required by contract.

Rejection records-DA.-Mechanical defect data are recorded on defective apparatus (DA) tags. Among information included are a description of the defect and corrective action.

Rejection records-DR.-Electrical nonconformances encountered from bench test through final test are documented by the use of a discrepancy report (DR). In addition to identifying and control data, DR information includes results of discrepancy investigation and statements of corrective action.

Submittal records.-Submittal records document both the results of Westinghouse inspection and test, and of Government review of records and equipment, at selected points.

Serialization control.-Westinghouse serial numbers are applied to assemblies and selected fabricated items prior to inspection in order to provide positive identification and control.

Configuration and serialization record.-Records are retained of delivered equipment to identify the configuration by part number, revision letter and serial number of assemblies at the time of shipment.

Traceability of materials.-When required by contract, records of purchased articles and materials are maintained in such a manner that the source is identifiable.

Corrective action.-A system of information feedback is maintained in conjunction with a corrective action program to prevent recurrence of nonconformances, malfunctions, or failures, for both purchased items and in-house operations.

Failure analysis.-In the Product Reliability Assurance Laboratory (PRAL), analysis of selected component failures determines the failure mode. Defect classification is made and corrective action initiated. Equipment test failure data is collected, tabulated, analyzed, and disseminated to facilitate corrective actions.

Area audits.-Areas are audited periodically to assure conformance to operating procedures and requirements. These audits include manufacturing, inspection, and test functions. Audits are documented and include descriptions of any deficiencies found, responsibility, and effective date of corrective action.

Product Audits.-Typical units of equipment are audited periodically to assure conformance to drawing, specification, workmanship, and contract requirements. These audits are documented and include descriptions of any nonconformances found, and corrective action to be taken.

Special environmental control.-Special environmental control is maintained in areas of fabrication and test as required by the contract, or as necessary for the equipment to meet functional requirements. This includes the necessary controls over parts and processes to make possible sterilization of the end product.

Process control.-Two such controls are:

- Process and equipment certification.-Equipment and processes are certified when required by contract or applicable Military Specifications. In addition, certain processes not covered by Military Specifications are certified where control is deemed necessary to assure product quality and reliability.

- Process audit.-Manufacturing processes are periodically audited to assure continuing conformance to applicable requirements.

Nonconforming Material

Nonconforming material which cannot be reworked to drawing/specification requirements is subjected to review by a Material Review Board (MRB) for approval of repair procedures and/or acceptance for "as is" use. The MRB is composed of a Government Representative and government approved members of the Engineering and Product Reliability Departments. Facilities are provided for the segregation and positive identification of the nonconforming material.

Inspection, Measuring and Test Equipment

Measuring and testing equipment.-Westinghouse operates complete and up-to-date test and measuring facilities to assure that produced items conform to technical requirements. Procedures which conform to MIL-C-45662A, "Calibration System Requirements," are maintained for the calibration, control and approval of measurement and test equipment.

Production tooling used as media of inspection.-When tools, jigs, fixtures and other such devices serve as media of inspection, they are inspected or proved by suitable mean for accuracy prior to release for use. These devices are re-inspected or proved at established intervals.

Inspection Stamps

Evidence of inspection/test acceptance status is controlled by a system of stamps. The stamps are numbered and assigned to the individual inspectors and test technicians.

Preservation, Storage, Handling, Marking, Packaging, and Packing

Preservation, storage and handling procedures.-Procedures for the handling and storage of material, parts and assemblies in a safe and adequate manner are in effect throughout Aerospace Division facilities. These include identification methods, protection of finishes, control of Government property, and control of limited life supplies, materials and parts. Also, existing procedures provide for the cleaning and preservation of material, parts, and assemblies necessary to prevent deterioration through exposure to air, moisture or other elements during fabrication, handling or storage.

Marking, packaging, and packing procedures.-Equipment is identified by marking in accordance with applicable MIL and/or contract requirements. Packing and packaging procedures also require compliance to MIL and/or con ract requirements. When not specified by contract, the methods used are specified by Packaging Engineering. Tests on packing and packaging materials are performed on a sampling basis to assure their environmental and physical adequacy. Accuracy of the shipping documents is verified prior to shipment. Units, packages and documents are available to Government Inspection.

Statistical Quality Control

Statistical sampling.-Sampling inspections are in accordance with MIL-STD-105 or MIL-STD-414 and applicable Station Inspections. Quality levels of sampling are appropriate to the complexity, function, and quality required of the end item.

Control charts.-Control charts in selected areas and for certain equipment provide statistical data of quality levels and controls, as well as program visibility.

Training and Certification of Personnel

Personnel training.-Inspection personnel are subjected to continuing training programs to assure orientation and indoctrination in quality assurance procedures, methods, and techniques. Employees whose skills contribute directly to quality are subjected to specialized training to assure that their skills and knowledge keep pace with the technology required to achieve optimum performance.

Personnel certification.-Personnel performing certain operations and tasks are certified when required by contract or applicable Military Specifications. In addition, personnel performing certain operations not covered by Military Specifications are certified by Westinghouse where such control is considered necessary to assure product quality and reliability.

EFFECTS OF STERILIZATION ON RELIABILITY

Contamination and Sterilization

Sterilization is required to preclude contaminating the destination environments of deep space probes. The requirements have been the object of previous studies by Space Department personnel at the Westinghouse Defense and Space Center. One result of such study is a report titled "Voyager Lander/Capsule Science Payload Integrated Study," dated 30 June 1965. It examines the effects of sterilization and decontamination on materials and components, and is particularly applicable to the SPRA program. The electrical and electronic parts considered in the subject report, except for those parts unique to the particular system, are the same type parts considered for application in the Space Probe Radar Altimeter.

Specifications

The environmental specifications used for the SPRA study are described in JPL Specification VOL-50503-ETS, dated 12 January 1966, and titled "Environmental Specification, Voyager Capsule Flight Equipment, Type Approval and Flight Acceptance Test Procedures for the Heat Sterilization and Ethylene Oxide Decontamination Environments."

This specification describes a piece part and material compatibility test. It requires (1) six cycles of ethylene oxide decontamination at 50°C for approximately 30 hours each cycle, and (2) six cycles of heat sterilization at 135°C for 96 hours each cycle. Westinghouse's major effort has been to ascertain the level of degradation of part reliability due to these tests.

Effect on Parts

Parts required in the altimeter design and fabrication are as follows:

Diodes - silicon rectifier, switching, zener varactor, mixer and high power
Transistors - high and low power
Resistors - wirewound, carbon and metal film
Potentiometers - wirewound
Capacitors - tantalum, ceramic, mica, metalized paper
MIC's - analog and digital
Inductors - fixed and variable
Coils - RF
Transformers - pulse and high frequency
Connectors

Transistors, diodes and integrated circuits are thermally stabilized during the manufacturing process at temperatures above 145°C. Therefore they present no problem under the sterilization environment. Carbon resistors will withstand 145°C temperature without degradation as long as they are not operated during the test.

It is JPL's conclusion that particular types of resistors from various manufacturers appear more prone than others to failure or parameter drift. Wirewound and metal film resistors show little tendency to drift after test.

Ceramic capacitors show a temporary increase in capacitance and dissipation factor after test. This variation will have to be taken into consideration during circuit design.

Tantalum capacitor tests run by JPL indicate a decrease in insulation resistance by a factor of ten. The insulation resistance increased to the original level after operation at high temperature and rated voltage; however, catastrophic failure occurred in some units. To obtain reliable tantalum capacitors specifications, detailing appropriate thermal screening and inspection will be necessary.

There is no data available at this time on inductors, transformers, coils and connectors. However we foresee no particular problems with these units since designs are currently available for temperatures above 145°C.

Intended Procedure

Through the following procedures, Westinghouse intends to prevent degradation of reliability due to sterilization:

(a) Establishing an approved list of heat sterilizable parts.

(b) Employing specifications which ensure that only those parts having a capability of sterilization are procured.

(c) In-house testing of samples from lots of parts to ensure part integrity and correctness of vendor data.

Appendix A

DISCREPANCY REPORTING SYSTEM

I. PURPOSE

The Discrepancy Report is the transmittal means for providing a complete, rapid, and accurate reporting of all discrepancy, trouble, failure, maintenance, and consumption data for the product support effort.

The information obtained from the reporting system will be utilized for obtaining corrective action on product problems, for reliability and maintainability measurements, and for quick and accurate feedback to all inplant and field functions.

II. ISSUANCE OF DISCREPANCY REPORT

The Discrepancy Report will be issued whenever one of the following conditions exist:

A. Item failure/malfunction - An item's performance is outside specification tolerances (catastrophic failure or out of tolerance drift).

B. Item discrepancy/deficiency - An item has inherent design discrepancies or deficiencies such as, part misapplication, circuit misapplication, packaging problem, etc.

C. Secondary/associated failure - An item has failed to meet performance specifications due to the malfunction of another item (primary failure) within the equipment.

D. Corrective measure - An unscheduled adjustment or other corrective measure was required to return the item to operation status.

E. Maintenance deficiency - A deficiency in the maintenance requirements of an item, which does or may detrimentally affect functional operation of the item.

F. Unscheduled preventative maintenance - An unscheduled adjustment or other preventative maintenance action to maintain an item in operational status, and which is not specifically designated as allowable in the governing test specification or technical publication.

G. Workmanship error - An error in workmanship either during manufacture or repair/rework of the item which degrades the item's performance.

H. Operator error - An error by personnel responsible for the performance of a test or operation of the item, which caused the item to perform outside its performance specifications.

I. Procedural error - An error in test specification, technical publication, etc., which through strict adherence to the directive caused or could cause item performance outside specification limits, or operation at reduced capability.

III. WHEN TO ORIGINATE DISCREPANCY REPORT

Reporting of any of the above conditions or actions is required whenever such condition or action occurs during environmental/qualification test, circuit check, bench/unit test, semi-composite/major assembly test, composite/system test or all field operations. Reporting should be accomplished as soon as the discrepancy is definable, but not later than twenty-four hours after first indication of the condition or action.

IV. DISPOSITION AND HANDLING OF DISCREPANCY REPORT

In the event a reportable condition or action occurs, the following will be followed for reporting the occurrence and transmitting the required follow-up information:

A. In-Plant

1. Originator

a. Complete blocks 1 through 20b.
b. Obtain Supervisor's approval in block 20c.
c. Forward copy 4 to Reliability Engineering.
d. Attach remaining copies of Discrepancy Report to discrepant item.

2. Repair/Rework Activity

a. Complete blocks 21 through 34.
b. Obtain Supervisor's approval in block 34.
c. Remove copy 3 (Production copy) for requisition of new parts.

3. Manufacturing

a. Complete blocks 35 through 43 on copies 1, 3, 5, 6.

b. Retain copy 3.
c. Forward discrepant item and copies 1, 2, 5 and 6 of discrepancy report to Product Reliability Analysis.

4. Product Reliability Analysis

a. Complete blocks 28, 44 and 45 through 54 as applicable.
b. Retain copy 5.

5. Reliability Engineering

a. Complete blocks 45 through 54 as applicable.
b. Retain copy 2.

B. In-Field

1. Originator

a. Complete blocks 1 through 20c.
b. Forward copy 4 to Reliability Director of Project, Baltimore Defense Center.

2. Repair/Rework Activity

a. Complete blocks 31 through 34, and 45 through 48.
b. Forward to Reliability Director of Project, Baltimore Defense Center, copies 1,2,3 and 6 attached to discrepant item if item is to be scrapped.
c. Retain copy 5 for own consumption.

3. Copies 1,2,3 and 6 stay with lowest level item being sent to supply depot or Baltimore for repair.

V. INSTRUCTIONS FOR COMPLETION OF DISCREPANCY REPORT

A. Portion To Be Completed by Test/Maintenance Personnel

<u>Block 1.</u> <u>Reporting Activity</u> - Enter the name of the department, agency, etc. reporting the failure, action, or condition.

<u>Block 2.</u> <u>Date</u> - Enter month, day, and year the failure occurred, action took place, or condition was noted.

<u>Block 3.</u> <u>Location</u> - Enter the name of the facility, vehicle's name or location at which reportable occurrence took place.

Examples: WP (Westinghouse-Parker Road),
WE (Westinghouse-Electronics),
AVM-1, etc.

Block 4a — System Name - Enter name of top-level system in which failure or action was noted.

Esamples: SPG-59, TPS-27, etc.

Block 5a — Model Designation - Enter model designation of system for which item involved is, or normally would be, a part there of. (If item is not assigned to any particular model, leave blank).

Examples: XZ-1, etc.

Block 6a — System Serial Number

O. Original - Enter serial number of system in which failure or action occurred. (Leave blank if item involved is not part of a specific system).

R. Replacement - Enter serial number of replacement system if original system has been removed. (If not, leave blank).

Block 7a — Reference Designation - Enter reference designation for system listed in block 4a.

Block 8a, b, c, d, Operating Time - Indicate whether operating time is from a meter or estimated from watch time, operation logs, etc. by checking appropriate block.

If operating time is by meter, then:

1. (O) Indicate meter reading associated with original unit in blocks 4a, b, c, d, and 6a, b, c, d.

2. (R) If meter in O. above has been removed, either by itself or in a discrepant unit, indicate new meter reading of replaced unit.

3. If operating time is estimated, put estimate in appropriate unit level.

4. Circle "Hrs." or "Cyc." indicating whether units are in hours or cycles.

Block 9a — System Supplier - Enter name of supplier of system listed in block 4a.

Examples: WE (Westinghouse-Electronics), Bendix, etc.

Block 4b — Assembly Name - Enter drawing nomenclature of major assembly or enclosure in which failure or action occurred.

Examples: Transmit Array, Radar Computer Enclosure, etc.

Block 5b — Assembly Drawing Number - Enter Westinghouse drawing number for major assembly listed in block 9.

Examples: Receiver AN/DPN-53

Block 6b — Assembly Serial Number

O. Original - Enter serial number of assembly in which failure or action occurred. (Leave blank if item is not a part of a major assembly).

R. Replacement - Enter serial number of replacement assembly if original assembly has been removed. (If not, leave blank).

Block 7b — Assembly Reference Designation - Enter designation localizing assembly to specific function in system.

Examples: 408, 201, etc.

Block 9b — Assembly Supplier - Enter name of supplier of major assembly listed in block 4b.

Examples: WE (Westinghouse-Electrics), WAA (Westinghouse-Air Arm), etc.

Block 4c — Subassembly Name - Enter drawing nomenclature of next lowest level assembly in which failure or action occurred.

Block 5c — Subassembly Drawing Number/Printed Circuit Code
Enter Westinghouse drawing number or printed circuit code of subassembly listed in Block 4c.

Block 6c Subassembly Serial Number

O. Original - Enter serial number of subassembly in which failure or action occurred.

R. Replacement - Enter serial number of replacement subassembly if original subassembly has been removed.

Block 7c Subassembly Reference Designation - Enter reference designation for subassembly listed in Block 14 as imprinted on the next higher-level assembly listed in Block 4c.

Examples: 408 A001, 201 A001

Block 9c Subassembly Supplier - Enter name of supplier for subassembly listed in Block 4c.

Examples: WE (Westinghouse-Electronics), WAA (Westinghouse-Air Arm), etc.

Block 4d Module Name - Enter drawing nomenclature of next lowest level subassembly in which failure or action occurred.

Block 5d Module Drawing Number/Printed Circuit Card Enter Westinghouse drawing number or printed circuit code of module listed in Block 4D.

Block 6d Module Serial Number

O. Original - Enter serial number of module in which failure or action occurred.

R. Replacement - Enter serial number of replacement module if original module has been removed.

Block 7d Module Reference Designation - Enter reference designation for module listed in Block 4D as imprinted on the next higher-level assembly listed in Block 4c.

Examples: 408 A001 A01, 201 A001 A01

Block 9d Module Supplier - Enter name of supplier for module listed in Block 4D.

Examples: WE (Westinghouse Electric), etc.

Block 10. Shop Order Number - Enter shop order number (PLANT USE ONLY).

Block 11. Test Level of Discrepancy - Enter the level of test that item was in when failure or action occurred.

Normal Operation - Indicate whether this was a normal operation function by checking appropriate box.

Preventative Maintenance - Indicate whether this was a preventative maintenance function by checking appropriate box.

Block 12. Test Specification/Paragraph Number - If discrepancy, failure, or action was noted during a specific test or functional operation which could be identified by a specific Test Specification or Technical Publication, enter the document number, and the associated paragraph number.

Block 13. Mode of Operation - Enter the specific function of equipment or mode of operation when failure or action occurred.

Examples: Track While Scan Mode, etc.

Block 14. Sympton of Discrepancy - Check that box which corresponds to the best description of the indicator of the failure, action or condition. (If none of the blocks are appropriate, check "OTHER" and explain further in Block 19).

Block 15. Reference Other Reports - Reference any other correspondence, Discrepancy Reports, or reports which have been originated as a result of the failure, action, or condition.

Block 16. Apparent Cause of Discrepancy - Check that box which is the best estimate at the time of occurrence of the apparent cause of the failure, action, or condition. (If none of the blocks are appropriate, check "OTHER" and explain further in Block 19).

Block 17. Immediate Corrective Action - Check that box which indicates the immediate corrective action taken on the highest-level replaceable item to restore the system to operational status. (If none of the items are appropriate, check "OTHER" and explain further in Block 19).

Block 18. System Down Time - Indicate to the nearest tenth of an hour, the total time to restore the system to operational status.

Block 19. Description of Discrepancy - Enter brief but clear narrative describing the failure, action, or condition, and the action taken to ~~prevent~~ prevent recurrence, if any. Include any information that appears to be pertinent to the conditions surrounding the occurrence.

Block 20. Reported By - Signature of person reporting occurence.

Block 20A Department - Department of person in Block 20. (PLANT USE ONLY).

Block 20B Date - Date that Discrepancy Report was written by person in Block 20 (not necessarily the same as Block 2).

Block 20C Approved By - Signature of supervisor of person in Block 20. (PLANT USE ONLY).

B. Portion To Be Completed By Repair/Rework Personnel

Block 21. Conditions Found During Repair/Rework - Enter brief but clear narrative describing conditions found during repair/rework of unit, such as components worn excessively, dimensions out of tolerance, etc.

Block 22. Total Maintenance Time

22A. Diagnosis - Enter the time that it took in the repair/rework area to isolate the discrepancy in the removed unit.

22B. Repair - Enter the time that it took in the repair/rework area to repair the discrepant unit.

22C. Retest - Enter the time that it took to retest the unit after repair/rework. Indicate whether unit passed or failed retest.

Block 23. Examination - Indicate whether unit can be failure verified and/or failure analyzed.

23A. Signature - Person giving authorization.

23B. Date - Date of authorization.

Block 24A, B, C, D, Part Name - Enter drawing nomenclature of part/parts replaced.

Block 25A, B, C, D, Drawing/Part Number - Enter Westinghouse drawing number of part/parts replaced. If none exists, then enter suppliers part number.

Block 26A, B, C, D, Complete Circuit Symbol - Enter the complete circuit symbol of part/parts replaced as imprinted on next-higher level assembly.

Block 27A, B, C, D, Part Serial Number - Enter serial number of part/parts replaced.

Block 28A, B, C, D, Charge Number - Enter charge number for this particular repair/rework action. (PLANT USE ONLY).

Block 28A, B, C, D, Federal Stock Number - Enter federal stock number corresponding to drawing/part number in block 26a, b, c, d. (FIELD USE ONLY).

Block 29A, B, C, D, Section - Enter section name where charge number is applicable. (PLANT USE ONLY).

Block 30A, B, C, D, Supervisor - Signature of supervisor authorizing charge number. (PLANT USE ONLY).

Block 31. Repaired/Reworked By - Signature of person making repair/rework action on item.

Block 32. Department - Department of person in Block 32. (PLANT USE ONLY).

Block 33. Date - Date that repair/rework action was completed.

Block 34. Approved By - Signature of supervisor of person in block 32. (PLANT USE ONLY).

C. Portion To Be Completed By Production Department Personnel

Blocks 35 through 44 are to be completed by production department personnel as applicable.

D. Portion To Be Completed By Product Reliability/Engineering Services/Part Analysis Personnel.

Before filling out the following blocks, remove carbon from between copies 1,2 and 3. Fold flip-out copies 2 and 5 so that they are back to back with copy 6. Place carbon between bottom portion of copies 2,5 and back of copy 6. Information of copies 2,5 and back of 6 must be legible.

Block 45. Effect on System Performance - Check appropriate block to indicate the effects of this particular discrepancy on the system's performance. Explain further in space provided, if necessary.

Block 46. Actual Cause of Discrepancy - Enter brief but clear narrative describing the actual cause of discrepancy, if known. If not determined or not determinable, so indicate.

Block 47. Was Failure Verified - Check appropriate block to indicate whether failure of unit was verified.

Block 48. Failure Verified By - Signature of person verifying failure.

Block 49. Predicted Failure Rate - Indicate part predicted failure rate, if known.

Block 50. Was Failure Analysis Performed - Check appropriate block to indicate whether unit failure analysis was performed.

Block 51. Failure Analysis By - Signature of person performing failure analysis.

Block 52. Actual Failure Rate - Indicate part actual failure rate, if known.

E. Portion To Be Completed By Reliability Engineering/Product Reliability Analysis/Design Engineering Personnel.

Block 53. Failure Analysis Results - Enter a brief narrative describing the results of the unit failure analysis.

Block 54. Comments - Enter any additional information that may be appropriate, such as, recommendations for corrective action, corrective action taken, etc.

DISCREPANCY REPORT

REPORT NO. K 6134

		1 REPORTING ACTIVITY	2. DATE	3 LOCATION		
UNIT LEVEL	4 NAME	5 MODEL DESIGNATING/ DRAWING NO./PC CODE	6 SERIAL NO. O.-ORIGINAL UNIT R.-REPLACED UNIT	7 REFERENCE DESIGNATION (INCLUDE POSITION NO. AND CIRCUIT SYMBOL)	8 OPERATING TIME ☐ METER ☐ ESTIMATE	9. SUPPLIER
A SYSTEM			O R		O R HRS/CYC	
B ASSY			O R		O R HRS/CYC	
C SUB-ASSY			O R		O R HRS/CYC	
D MODULE			O R		O R HRS/CYC	

10 SHOP ORDER NO — 11 DISCREPANCY DETECTED DURING ☐ NORMAL OPERATION ☐ PREVENTIVE MAINT ☐ TEST LEVEL — 12 TEST SPEC./PARAGRAPH NO. — 13 MODE OF OPERATION

14 SYMPTOM OF DISCREPANCY ☐ INTERMITTENT ☐ OVER-HEATING ☐ NOISY ☐ OUT OF TOLERANCE ☐ OFF FREQUENCY ☐ UNSTABLE ☐ NO OUTPUT ☐ OTHER (EXPLAIN IN BLOCK 19) — 15 REFERENCE OTHER REPORTS

16 APPARENT CAUSE OF DISCREPANCY ☐ DESIGN ☐ WEAROUT ☐ WORKMANSHIP ☐ SECONDARY FAILURE ☐ OPERATOR ERROR ☐ MISHANDLING ☐ OTHER (EXPLAIN IN BLOCK 19)

17 IMMEDIATE CORRECTIVE ACTION ☐ REPAIRED IN PLACE ☐ REPLACED ☐ ADJUSTED ☐ MODIFIED ☐ SERVICED ☐ CLEANED ☐ OTHER (EXPLAIN IN BLOCK 19) — 18 SYSTEM DOWN TIME

19 DESCRIPTION OF DISCREPANCY (INCLUDE ENVIRONMENT)

2

20 REPORTED BY — A DEPT — B DATE — C APPROVED BY

TEST MAINTENANCE

RELIABILITY ENGINEERING COPY 1

21 CONDITIONS FOUND IN REPAIR/REWORK

22 TOTAL MAINTENANCE TIME — A DIAGNOSIS — B REPAIR-REWORK — C RETEST — ☐ PASSED ☐ FAILED — 23 EXAMINATION ☐ VERIFY FAILURE ONLY ☐ FAILURE ANALYSIS REQUESTED — A SIGNATURE — B DATE

	24 PART NAME	25 DWG OR PART NO	26 COMPLETE CIRCUIT SYMBOL	27 SERIAL NO	28 CHARGE NO F.S.N NO	29 SECT	30 SUPERVISOR
PRIMARY ITEM A							
SECONDARY ITEM B							
C							
D							

31 REPAIRED OR REWORKED BY — 32 DEPT — 33 DATE — 34 APPROVED BY

35 ISSUING INSPECTOR — 36 DEPT — 37 DATE — 38 P.O. NO — 39 DELIVER TO — DEPT — DEPT

40 ISSUING PROD. CLERK — 41 DEPT — 42 DATE — 43 PRI. ITEM MFR. & VENDOR IF DIFF — 44 FINAL DISPOSITION ☐ SCRAP ☐ REPAIR ☐ RETURN TO SUPPLIER ☐ RETURN TO CUSTOMER

REPAIR/REWORK — PROD.

INVESTIGATION OF DISCREPANCY AND CORRECTIVE ACTION

45 EFFECT ON SYSTEM OPERATION ☐ DEGRADING ☐ INOPERATIVE ☐ MINOR ☐ OTHER (EXPLAIN)

46 ACTUAL CAUSE OF DISCREPANCY

SIGNATURE — SIGNATURE

PROD. REL. /FEES/PART ANAL.

47 FAILURE VERIFIED ☐ YES ☐ NO — 48 FAILURE VERIFIED BY — 49 PREDICTED FAILURE RATE

50 FAILURE ANALYSIS ☐ YES ☐ NO — 51 FAILURE ANALYSIS BY — 52 ACTUAL FAILURE RATE

53 FAILURE ANALYSIS RESULTS AND FEASIBILITY OF REPAIR

SIGNATURE

54 COMMENTS (RECOMMENDATIONS FOR CORRECTIVE ACTION)

SIGNATURE

REL. ENGRG./PROD. REL. ANAL./DESN. ENGR.